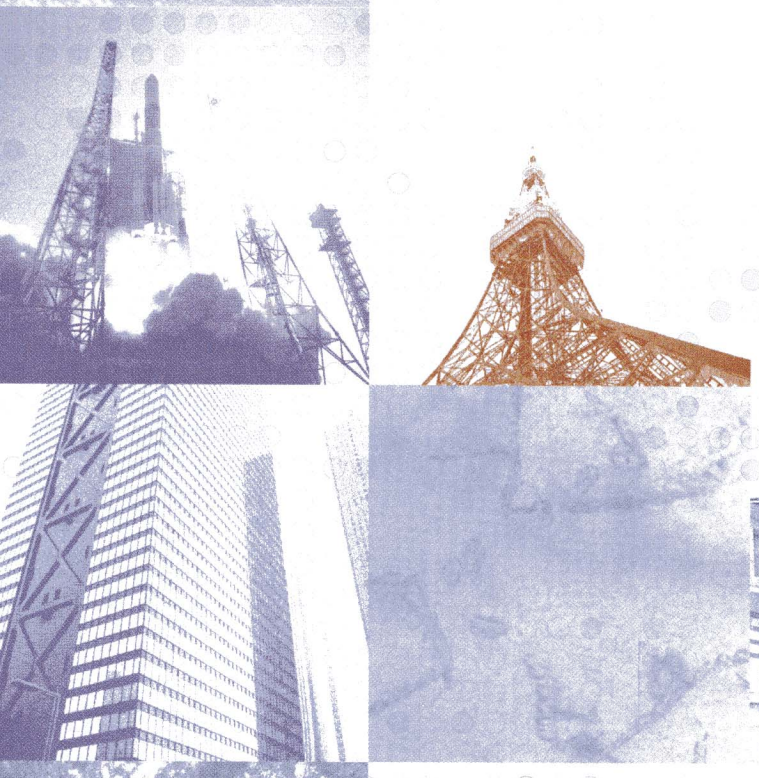
Truth • Technology • Teaching • Teamwork • Tomorrow

Non Destructive Evaluation and Science Research Center

岩手大学工学部附属 金属材料保全工学研究センター

The Non Destructive Evaluation (NDE) and Science Research Center was established in the Faculty of Engineering of Iwate University at the beginning of the 21st century with a new concept of NDE. Our aim is to contribute to the eternal peace of the world through the preservation of the social foundation and the natural environment from the viewpoint of the technology.



since april, 2001

NDE & Science Research Center

http://www.ndesrc.eng.iwate-u.ac.jp/

Non Destructive Evaluation
and Science
Research Center

Introduction

Since the 1950's, Japan has made tremendous economic progress. Many technologies and products developed by Japanese industries have been accepted as world standards. Now, people can enjoy convenient and comfortable lives. On the other hand, however, accompanying the benefits of advanced technologies, new problems have arisen which scientists must carefully consider. Among these problems, safety is the most important issue.

Currently, theories are based on theories. The latest theories become more complicated and sometimes difficult to understand. Due to the misunderstanding of modern technology, we have encountered unexpected problems, and even disasters to some extent, in both the usage and the development of products. During the last ten years, we have experienced a variety of serious technological disorders due to breakdowns in the transportation system, energy supply system, communication network, and so on.

What especially caused great concern were the accidents which occurred in nuclear power plants (NPPs). The construction of new NPPs has become almost impossible in some countries, and thus extending the lifetime of existing NPPs from 40 to 60 years has become very important for both low cost energy and for profit. The lack of specimens for testing for pressure vessels, however, is a serious problem. To ensure the safe operation of nuclear power plants, development of a nondestructive method to test, analyze, and evaluate employed materials and systems is urgently required. Such a method is also needed to clarify what has happened and to predict what will happen in the nuclear power generating system.

The Non Destructive Evaluation (NDE) and Science Research Center of Iwate University was founded at the beginning of the 21st century with a new concept of NDE. The study presently being conducted aims to clarify the long-term degradation process of materials used to make pressure vessels, especially in NPPs. We hope to give people confidence in the safety of new technology.

New Concept in Non Destructive Testing and Evaluation

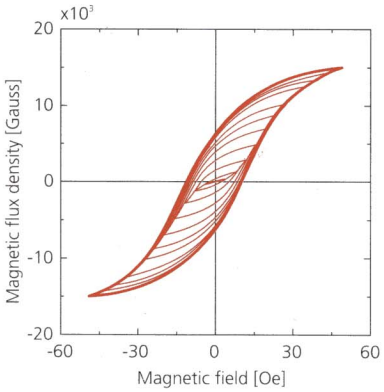
Metal materials have a life span similar to that of human beings. People's life cycle is from birth to illness and then to death. Similarly a material's life also covers commencement of use, degradation and failure. Many researchers have been studying how to predict the life span of materials. However, most studies are confined to detecting cracks. In practice, however, before cracks occur there are already a variety of defects, such as dislocations, vacancies, etc., in the materials. The reason why accidents due to metal fatigue never cease to occur is because a fracture may start at a dense defect site, and propagate rapidly in the case of impact loads, such as, earthquakes. At our center, the degradation process in materials from commencement of service to the appearance of cracks is being investigated. We intend to find a way to predict the length of time before the appearance of cracks. In short, traditional research is like treatment after an illness begins, while our new approach is to predict and prevent illness. For the first time anywhere in the world, our center is thus conducting cutting - edge research.

Magnetic Method in Degradation Evaluation

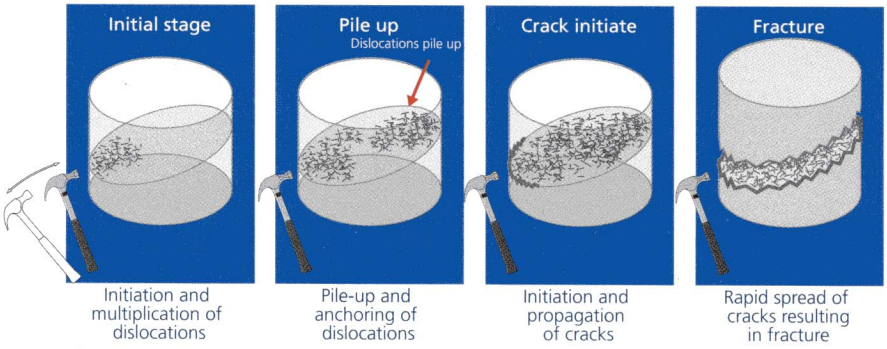
With the passage of time, the external cyclic load causes defects such as dislocations to propagate and accumulate in metal materials. This is called metal fatigue. In the future, theoretical and experimental study of defect density and material degradation will generate much interest.

For the past 30 years, the Faculty of Engineering at Iwate University has carried out pioneering work on the relationship between magnetism and dislocations. As a result, it has been found that there is a close relationship between the state of degradation and the magnetic properties in metals and alloys. For example, in low carbon steels, the coefficient of magnetization (c parameter) is a very sensitive parameter of dislocation density. If this relationship can be clearly established, degradation in metals and alloys can be predicted by measuring magnetic properties.

Iwate University and the Max-Planck Institute in Germany are the only institutions in the world that are actively involved in this research field.

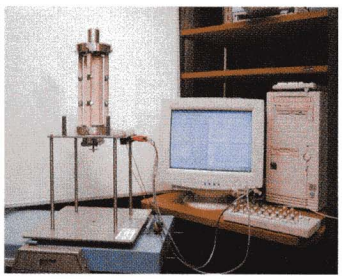


● Minor Loop

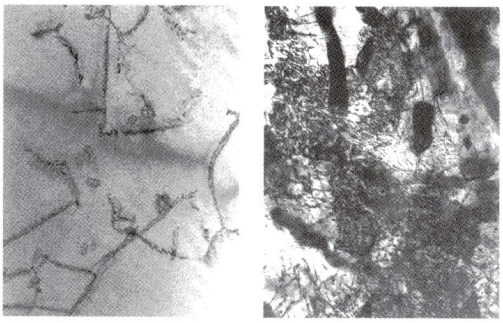


● The Process of Metal Fatigue

Under external cycling force, initiation and multiplication of dislocations take place, and consequently, with movement, pile-up and anchoring of dislocations occurs and micro-cracks are initiate, which propagate and result in fracture.



● Equipment for measuring magnetic properties of Charpy impact test pieces.



● TEM microphotographs showing dislocation defects in steel.

Equipment for the Evaluation of RPV

The evaluation of reactor pressure vessel (RPV) integrity is performed by destructive mechanical strength examinations with Charpy impact tests of surveillance test pieces that are made of the same material as real RPVs and exposed to neutron irradiation in the respective nuclear reactor. Long-term surveillance of the operation of nuclear power reactors is, however, hindered by a shortage of surveillance test pieces. Hence, a device has been developed to evaluate the degree of material degradation of RPV by nondestructive magnetic measurement of Charpy impact test pieces in our center.

Magnetic Minor Hysteresis Loop

The relationship between magnetism and the microstructure of ferromagnetic materials has been studied by use of the major hysteresis loop, in which the applied field is more than 100 Oe (the strength of geomagnetism is 0.48 Oe). We have used the major hysteresis loop at our center and have recently developed a new evaluation method using minor hysteresis loops of late. The new method due to the minor loop analysis has several advantages compared with that of the major loop, namely, much information about lattice defects, high accuracy, and capability by low field measurement of 20 Oe. A patent for the minor loop method has been applied in Japan, the USA, Canada and Europe, and the fundamental content of the analysis has been published in international journals.

Contribution to Education

The safety of society is expected to be the focus of a new field of study in the 21st century. Although research on nondestructive evaluation has just been started, our center will develop technology necessary to take the lead in making it available to society.

At the same time, our aim is not only to provide information forthcoming from efforts at Iwate University and the Max-Planck Institute to the next generation, but also to train young people, so that they will be able to contribute to society. We hope students at our center will acquire great insights, a broader outlook and a high degree of internationalism while doing research and by working hard in cooperation with local and foreign researchers.

Organization

Dislocation and Magnetism

Manager in Chief, Prof.	Seiki Takahashi
Associate Prof.	Yasuhiro Kamada

Micro-analysis of Lattice Defects

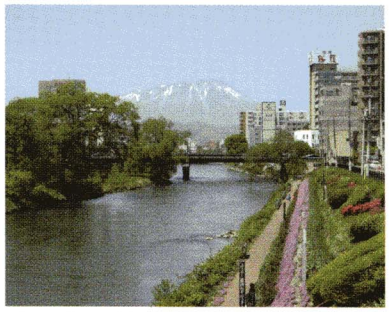
Research Associate	Vacant at present
Prof.	Junichi Echigoya

Non-Destructive Testing Device Development

Associate Prof.	Hiroaki Kikuchi
Visiting Prof.	Seitaro Ogiso
Associate Prof.	Hiroshi Hatafuku

Radiation Damage

Visiting Prof.	Katsuyuki Ara



View of Morioka in spring. The Kitakami River flows through the city.
In the background is Mt.Iwate.

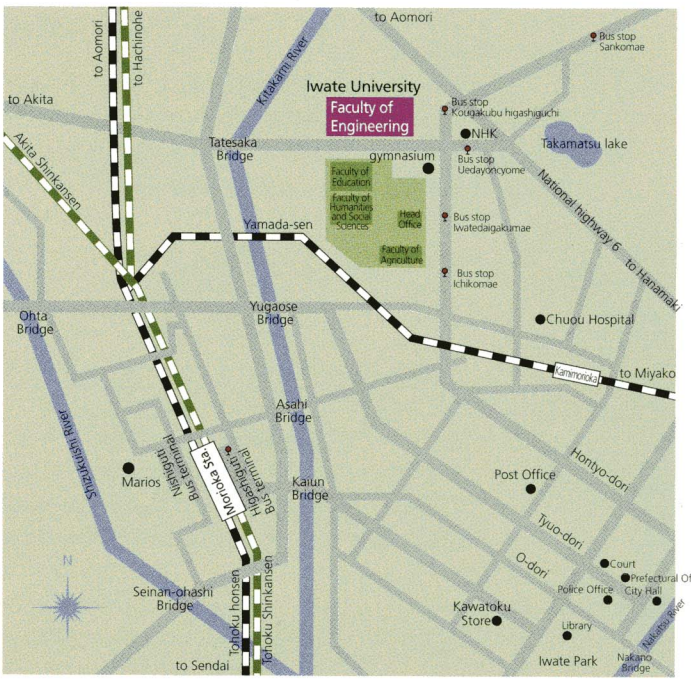
View of Takamatsu Lake near Iwate University in Winter. There are cherry blossoms in spring and swans come in winter.

Railway transportation

Tokyo-Morioka	2 hours 21 miniutes
Sendai-Morioka	44 miniutes

Air transportation

Sapporo-Hanamaki	55 miniutes
Tokyo-Hanamaki	1 hour
Nagoya-Hanamaki	1 hours 10 miniutes
Osaka-Hanamaki	1 hours 20 miniutes
Fukuoka-Hanamaki	2 hours 5 miniutes



Bus transportation

At Morioka Station Bus Depot take a bus (Iwate-ken Kotsu) for "Matsuzono Bus Terminal" and get off at "Ueda 4-chome"(In front of NHK) or take a bus (Iwate-ken Kotsu) for "Sakuradai danchi via Higashi Midorigaoka" and get off at "Kougakubu Higashiguchi" (East Gate of Faculty of Engineering).

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Meaning of the 5 colors
Purple : Truth
Blue : Technology
Green : Teaching
Yellow : Teamwork
Pink : Tomorrow
The concept of Non Destructive Evaluation

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